GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. ______

Project No. G-35-623 (G-35-333 cost share) DATE 3/31/82

Project Director: Dr. Gerald W. Grams School/Lab Geophysical Sciences

Sponsor: NSF; Washington, D. C. 20550

Type Agreement: Mod. 1 to Grant No. INT-8105102

Award Period: From 5/1/82 To 10/31/~~83~~ 84 (Performance) 1/31/84 (Reports)

Sponsor Amount: $12,698 Contracted through:

Cost Sharing: $1,425 GTRI/GIT

Title: Studies of Changes in the Characteristics of Particulates and Minor Species Across the Tropopause

ADMINISTRATIVE DATA OCA Contact Linda H. Bowman x-4820

1) Sponsor Technical Contact:

Ms. Marilyn Rurak
National Science Foundation
Washington, D. C. 20550

(202) 357-7554

2) Sponsor Admin/Contractual Matters:

Mr. Martin V. Geary
National Science Foundation
Washington, D. C. 20550

Phone (202) 357-9630

Defense Priority Rating: None

Security Classification: None

RESTRICTIONS

See Attached NSF Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT, but none proposed

COMMENTS:

Continuation of G-35-601 due to change in OH rate/base.

COPIES TO:

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FORM OCA 4.781

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 5/29/86

Project No. G-35-623 School/~~Lab~~ Geo. Sci.

Includes Subproject No.(s) N/A

Project Director(s) Dr. Gerald W. Grams GTRC / ~~GIT~~

Sponsor National Science Foundation

Title Studies of Changes in the Characteristics of Particulates and Minor Species Across the Tropopause

Effective Completion Date: 10/31/84 (Performance) 1/31/85 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [x] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [x] Final Report of Inventions - Patent Questionnaire to P.I.
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

Continues Project No. G-35-601 Continued by Project No.

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R. Embry

FORM OCA 69.285

G-35-623

Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
ATLANTA, GEORGIA 30332
SCHOOL OF GEOPHYSICAL SCIENCES
404/894-3893

31 MARCH 1983

6-35-623

Ms. Marilyn Rurak
Room 1214, International Programs
National Science Foundation
1800 G Street. N.W.
Washington, D.C. 20550

Dear Ms. Rurak:

This letter summarizes progress during the past year on the U.S.-Italy Cooperative Science Program's project "Studies of Changes in the Characteristics of Particulates and Minor Species Across the Troposphere" which is being carried out under NSF grant number INT8105102. After reviewing the discussion of our research plans in the original proposal, I am pleased to report that we are still making good progress on our original goals. The "U2 nephelometer" system that we described in the proposal was completed last year. It flew on the NASA Ames Research Center's U2 aircraft in October 1981, March 1982, July 1982, November 1982, and December 1982. On each of these flights, other "U2 experimenters" made simultaneous observations of aerosol characteristics such as particle mass concentrations, size distributions, and absorption coefficients.

The selection of observations that were made as part of the U2 aerosol measurement system was based on NASA's desire to define the optical and radiative properties of aerosol particles in the stratosphere for use in climate models. Aerosol particles are expected to cause significant climatic perturbations at times following volcanic eruptions that inject significant amounts of fine ash particles and sulfur-bearing gases into the stratosphere.

The eruption of the El Chichón volcano in the spring of 1982 was just such an eruption; in fact, some believe that it may turn out to be the most significant aerosol-climate perturbation of the past century. As a result, the expected frequency of U2 aerosol observations was stepped up appreciably in the past years time. This increased effort in NASA's U2 aerosol observation program has had both positive and negative implications with respect to our other work. Obviously, the existence of the El Chichon volcanic aerosol layer has been the subject of intense scientific interest, and we thereby benefitted from the unexpected opportunity for obtaining data on the El Chichón cloud. However, the intense interest in the cloud did result in a doubling of the number of U2 flights over the 2 per year outlined in NASA's original observation program. The larger number of days in the field has decreased the time that we have available for laboratory studies with the instrument. As it stands now, our laboratory studies on the H_2SO_4/water concentration rates are a little behind schedule; we should, however, be able to finish that work by Summer 1983.

In addition to the work that was completed on the polar nephelometer, we found that we were able to interact with Dr. Fiocco and his group in several other ways. Dr. Fiocco's group in Italy has made good progress on the development of their numerical model for aerosol formation and growth. On the basis of calculations with the model, Dr. Fiocco felt that water clouds should form in thin layers within the first few kilometers of the stratosphere in tropical regions. Since I am also a member of NASA's experiment team for the SAGE (Stratospheric Aerosol and Gas Experiment) satellite sensor, I had a set of computer tapes which stored the first year of data obtained by the SAGE satellite sensor which measures aerosol extinction coefficients versus altitude. This data on global aerosol distributions is stored on magnetic tapes with approximately 1-km altitude resolution. Dr. Fiocco and I decided that it would be of considerable interest to the Italian aerosol modelling effort to search our SAGE data tapes for evidence of the layers predicted by the model.

In accordance with the possibilities for joint work discussed in our original proposal, Mr. Luca Crescentini, one of the junior members of Dr. Fiocco's group in Italy, spent Summer 1982 in my laboratory to examine SAGE data tapes to search for the aerosol layers of the type suggested by the Italian aerosol model. Mr. Crescentini spent a good part of the summer developing computer programs for reading the tapes, identifying SAGE aerosol profiles with thin layers, and plotting all aerosol extinction profiles that displayed thin layers for use in comparisons with the Italian model. He completed a preliminary analysis of the SAGE data and left at the end of the summer with plans to continue the study in Italy. During the next year, we hope to see that work progress to the point at which conclusions can be finalized and results published.

With regard to future plans, we have enclosed our budget for the third year of our 3-year grant. During this coming year, we plan to complete the "U2 nephelometer" laboratory studies for determining H_2SO_4/water ratios in aerosol droplets, as discussed in last years report. We then expect to be able to apply our laboratory results to the polar nephelometer observations of light scattering particles in the El Chichón aerosol layer. These results may then be incorporated into the Italian aerosol model.

I am enclosing a list of my current and pending support with this letter. I am also enclosing our budget request for the third year of this grant, signed by Georgia Tech's Office of Contract Administration. Please contact me if you need any additional information.

With best wishes,

Gerald W. Grams
Professor
School of Geophysical Sciences

GWG:ejf
enclosures

G-35-5??

APPENDIX VII

NATIONAL SCIENCE FOUNDATION Washington, D.C. 20550	FINAL PROJECT REPORT NSF FORM 98A	
PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING		
PART I–PROJECT IDENTIFICATION INFORMATION		
1. Institution and Address School of Geophysical Sciences Georgia Institute of Technology Atlanta, GA 30332	2. NSF Program U.S.-Italy Cooperative Science	3. NSF Award Number INT-8105102
	4. Award Period From 5/8/81 To 10/31/84	5. Cumulative Award Amount $45,416
6. Project Title Changes in the Characteristics of Particulates and Minor Species Across the Tropopause		

PART II–SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

The goal of this project has been to conduct cooperative studies to improve our understanding of atmospheric processes taking place at the tropopause and in the lower stratosphere. The approach emphasized (a) the formation and evolution of stratospheric aerosol layers and (b) the vertical transport of water and other trace substances in the vincinity of the tropopause.

The project served to coordinate activities between the research group of Prof. Giorgio Fiocco at the University of Rome in Italy and the principal investigator's Atmospheric Optics research group in the School of Geophysical Sciences at Georgia Tech. The joint activities were to include (1) the development of analytical models, (2) observations and analysis of data obtained with ground-based lidar systems operated by the Italian group and (3) observations and analysis of data obtained with airborne instrumentation developed and operated by the American group. All of the above activities were carried out during this project. The eruption of the El Chichon volcano in Mexico during 1982 had a significant effect on the optical and radiative properties of the lower stratosphere and studies of stratospheric aerosol layers associated with that event were emphasised.

The project also served as a mechanism for scientists from each group to spend some time at their counterpart's institutions. The American principal investigator visited the Italian group twice during the program. The Italian principal investigator was able to visit the American group approximately once per year, and a research scientist from the Italian group spent one summer at Georgia Tech to work on part of the cooperative study.

PART III–TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM: Check (√)	TO BE FURNISHED SEPARATELY TO PROGRAM: Approx. Date
a. Abstracts of Theses	x				
b. Publication Citations		x			
c. Data on Scientific Collaborators		x			
d. Information on Inventions	x				
e. Technical Description of Project and Results		x			
f. Other *(specify)*					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
Prof. Gerald W. Grams		5/12/86

NSF Form 98A (3-83) Supersedes All Previous Editions — Form Approved OMB No. 3145-0058

Attachment b: PUBLICATION CITATIONS

Adriani, A., F. Congeduti, G.P. Gobbi, R. Ligi and G. Fiocco, 1985: The El Chichon aerosol cloud observed by lidar in Frascati, March 1982 - April 1984: backscattering and extinction. In IRS 84: Current Problems in Atmospheric Radiation (G. Fiocco, Ed.), A. Deepak Publishing, Hampton, Va.

Adriani, A., F. Congeduti, T. De Carolis, G. Fiocco, G.P. Gobbi, R. Ligi, G. Maltese e M. Viterbini, 1983: Misure di distribuzione degli aerosoli ed analisi della loro influenza sulla struttura verticale della radiazione diffusa. Rapporto Interno IFA/CNR 83/16.

Adriani, A., F. Congeduti, G. Fiocco and G.P. Gobbi, 1983: One-year lidar observations of the stratospheric aerosol layer following the El Chichon eruption. Geophys. Res. Lett., 10, 1005-1008.

Baker, M., and A. Coletti, 1982: Uncertainties in the evaluation of the shortwave radiative properties of an aerosol layer due to experimental and numerical errors. Appl. Optics, 21, 2244-2252.

Bais, A.F., C.S. Zerefos, I.C. Ziomas, N. Zoumakis, H.T. Mantis, D.J. Hofmann and G. Fiocco, 1985: Decreases in the ozone and SO_2 columns following the appearance of the El Chichon aerosol cloud at midlatitude. In Atmospheric Ozone (C.S. Zerefos and A. Ghazi, Eds.), Reidel Publishing.

Coletti, A., and G. W. Grams, 1982: Polar nephelometer measurements of laser light scattering by nonspherical particles. In NASA Conf. Publ. 2228 (Proc. 11th International Laser Radar Conference, Madison, Wisc., sponsored by Am. Meteor. Soc.).

Coletti, A., D.H. Hofmann and J.M. Rosen, 1985: Balloon-borne horizon photography of the stratospheric cloud of El Chichon. In IRS 84: Current Problems in Atmospheric Radiation (G. Fiocco, Ed.), A. Deepak Publishing.

Coletti, A., 1985: Light scattering by nonspherical particles: a laboratory study. Aerosol Sci. and Tech., 3, 39-52.

Crescentini, L., and G. Fiocco, 1983: Possible effects of stratospheric aerosol layers on the vertical transport of water. Nuovo Cimento, 6C, 337-349.

Fiocco, G., and G. Visconti, 1985: Gli effetti climatici delle eruzioni vulcaniche. Le Scienze/Quaderni, No. 20, 57-62.

Fiocco, G., A. Adriani, F. Congeduti, G.P. Gobbi and R. Ligi, 1984: Stratospheric aerosol loads consequent to the El Chichon eruption. In Stratosphere (A. Ghazi, Ed.), CEC Brussels.

Gobbi, G.P., R. Ligi, A. Adriani, G. Fiocco, and F. Congeduti, 1984: Two wavelength lidar observations of the stratosphere and inferences on the size distribtion of the El Chichon aerosols. In IRS 84: Current Problems in Atmospheric Radiation (G. Fiocco, Ed.), A. Deepak Publising.

Grams, G.W., 1984: Airborne polar nephelometer observations of stratospheric aerosol and Arctic haze particles during 1983 and 1984. In IRS 84: Current Problems in Atmospheric Radiation (G. Fiocco, Ed.), A. Deepak Publishing.

Grams, G.W., and A. Coletti, 1982: Analysis of nephelometer data obtained at the First International Workshop on Light Absorption by Aerosol particles. In Light Absorption by Aerosol Particles (H.E. Gerber and E.E. Hinman, Eds.), Spectrum Press, Hampton, Va.

Patterson, E.M., B.A. Bodine, A. Coletti and G. Grams, 1982: Volume scattering ratios determined by the polar and integrating nephelometer: A comparison. Applied Optics, 21, 394-397.

Patterson, E.M., and B.T. Marshall, 1982: Diffuse reflectance and diffuse transmission measurements of aerosol absorption at the First International Workshop on Light Absorption by Aerosols. Applied Optics, 21, 387-393.

Patterson, E.M., C.O. Pollard and I. Galindo, 1983: Optical properties of the ash from El Chichon volcano. Geophys. Res. Lett., 10, 317-320.

Attachment c: DATA ON SCIENTIFIC COLLABORATORS

American Group

The principal investigator for the American effort in this cooperative project was Dr. Gerald W. Grams, Professor of Atmospheric Sciences, School of Geophysical Sciences, Georgia Tech, Atlanta, Georgia. Other U.S. collaborators on the project were Dr. Edward M. Patterson, Senior Research Scientist, and Dr. Alessandro Coletti, Research Scientist. Both collaborators are members of the Aerosol Optics group in Georgia Tech's School of Geophysical Sciences. Dr. Coletti had been a member of Prof. Fiocco's laboratory prior to joining Georgia Tech in 1980.

During the collaborative program, the principal investigator made two trips to visit Dr. Fiocco's group in Italy. Each trip involved a visit of approximately two weeks. The first visit, during the summer of 1981, included interactions with Dr. Fiocco and his students at the University of Rome. It also included interactions with Dr. Fiocco's lidar research group at Frascati. This trip provided the opportunity to plan for a visit by Mr. Luca Crescentini to work with Dr. Grams at Georgia Tech during the summer of 1982. In the summer of 1984, Dr. Grams' second trip to Italy began with his participation in the International Radiation Symposium sponsored by the International Association of Meteorology and Atmospheric Physics in Perugia, Italy during the time period 21 - 29 August. This symposium was organized by Dr. Fiocco, the Italian principal investigator on this project. After the symposium, Dr. Grams spent an additional week with Dr. Fiocco and his collaborators at the University of Rome and at the Frascati lidar facility.

Italian Group

The principal investigator for the Italian group in this cooperative project was Dr. Giorgio Fiocco, Professor, Dipartimento di Fisica, Citta Universitaria, Roma, and Istituto di Fisica dell'Atmosfera, C.N.R., Roma. His collaborators included research scientists Luca Crescentini, Fernando Congeduti, Alberto Adriani, and Gianpaolo Gobbi, along with one of Dr. Fiocco's students, Giulio Maltese. Profs. Fiocco and Grams are both members of NASA's SAGE II satellite experiment team which meets approximately four times per year. Dr. Fiocco has been able to visit the Georgia Tech group at least once per year during the course of this project, usually as part of one of the NASA meetings. In addition, Mr. Luca Crescentini spent a summer working at Georgia Tech as part of the cooperative research program.

Attachment e: TECHNICAL DESRIPTION OF THE PROJECT AND RESULTS

The principal goal of this project was to carry out cooperative efforts to improve our understanding of the atmospheric processes which take place at the tropopause and in the lower stratosphere. In particular, the project was to emphasize those processes which are involved with (a) the formation and evolution of the stratospheric aerosol layers and (b) the vertical transport of water and other trace substances.

The approach for accomplishing these goals was to coordinate activities between the research group of Prof. Giorgio Fiocco at the University of Rome in Italy and the principal investigator's Atmospheric Optics research group in the School of Geophysical Sciences at Georgia Tech. The joint activities were to include (1) the development of analytical models, (2) observations and analysis of data obtained with ground based lidar systems operated by the Italian group, and (3) observations and analysis of data obtained with airborne instrumentation developed and operated by the American group. All of the above activities were carried out during the project. The eruption of El Chichon volcano in Mexico during 1982 had a significant effect on the optical and radiative properties of the lower stratosphere and studies of stratospheric aerosol layers associated with that event were emphasized during this project.

Effect of Stratospheric aerosols on vertical transport of water

Our first joint study, carried out before the eruption of El Chichon volcano, was an analysis of the characteristics of thin stratospheric aerosol layers and their possible effects on the vertical transport of water vapor. This project evolved from an analytical model proposed by Prof. Fiocco and members of his group. The lifetime of such aerosol layers is related to mechanisms for vertical transport of sulfur and water substance in particulate and gaseous forms. Fiocco and Grams (1971) had described a mechanism for sustaining thin layers of aerosol particles at the mesopause in a paper on the formation of noctilucent clouds. Dr. Fiocco and his colleagues felt that this mechanism could modify the "Brewer mechanism" for transport of water across the tropical tropopause. According to Brewer, air rising to the stratosphere through the ascending branch of the Hadley cell in the tropics will be depleted of water vapor such that the mixing ratio of water vapor in the stratosphere will not exceed the saturation mixing ratio for ice at the coldest point on the vertical temperature profile. However, experimental evidence suggests that the stratosphere is somewhat dryer than would be expected by the model, suggesting that other processes may be removing water or that condensation is occurring at water vapor concentrations below saturation values for ice.

It was felt that stratospheric aerosol layers might play a significant role in reducing the upward transport of water substance for values below those predicted by the classical Brewer mechanism. Some indication that high concentrations of stratospheric aerosol particles might affect the water content of the stratosphere are suggested by Mastenbrook's data. His first six years of measurements (beginning in 1964) showed an increasing trend which did not continue beyond 1969 or 1970. A possible interpretation of the trend is that the Mt. Agung eruption in 1964 had resulted in a desiccation of the stratosphere since observations of stratospheric aerosol loading by lidar and other techniques after the eruption show a gradual decline in aerosol concentration until the early 1970s when the particle loading returned to background levels.

A variation on the mechanism suggested by Fiocco and Grams for maintaining noctilucent clouds at the mesopause was regarded to be a possible explanation for the abnormally dry stratosphere after the Mt. Agung eruption. The basic idea stems from the fact that updrafts are expected at the equatorial tropopause in the rising branch of the Hadley circulation pattern. If one were to neglect diffusion for the sake of this discussion, a balance between sedimentation and vertical advection of the aerosol particles leads to a typical aerosol size which could be suspended at any given altitude, assuming that the particle is not growing or evaporating. If the particles are mixtures of water and sulfuric acid in any height region for which the water saturation vapor pressure is higher than the equilibrium value for the solution, the particles will increase in mass by acquiring water moleules. These particles will descend to lower altitudes, eventually reaching a lower level at which the thermodynamic conditions no longer allow the ratio between the two species in the particle to be maintained and some of the water will evaporate causing the particles to be smaller and lighter so that they are moved upward toward their original altitude. A population of aerosol particles might thereby be oscillating within a layer, drying the upper parts of the layer and building up the water vapor concentration at the lower boundary of the layer. Dr. Fiocco's analysis of the conditions for such a mechanism suggested that one would expect to see thin aerosol layers near the tropopause in equatorial regions.

The principal investigator is a member of NASA's SAGE (Stratospheric Aerosol and Gas Experiment) Experiment Team. The SAGE sensor was launched on a dedicated AEM-B (Atmospheric Explorer Mission B) satellite on 18 February 1979. The instrument operated until November 1981, producing 33 months of data on stratospheric aerosol and ozone concentration with 1-km vertical resolution with observations that varied slowly in latitude between 72° North and 72° South over four to five weeks per cycle. As a member of the experiment team, the principal investigator had access to computer tapes with aerosol observations prior to the time that NASA could achive the SAGE data tapes. As our first cooperative activity, one of Dr. Fiocco's collaborators, Luca Crescentini, spent a summer at Geogia Tech, conducting a systematic study of the data on the NASA tapes to search for thin aerosol layers near the tropopause region in equatorial regions. The results of that study were published by Crescentini and Fiocco (1983). Both Dr. Fiocco and the principal investigator are currently members of the experiment team for NASA's SAGE II satellite sensor which was deployed from the space shuttle as part of the Earth Radiation Budget Satellite on 5 October 1984. Future collaborative studies as members of the SAGE II Experiment Team are planned.

Observations of the Stratospheric aerosols from El Chichon

The eruption of the El Chichon volcano in Mexico (March 28 and April 4, 1982) produced what is believed to be the heaviest loading of stratospheric aerosol particles in the past century. Most stratospheric aerosol groups turned a major part of their attention to analyses of the atmospheric effects of the particles produced in the stratosphere by direct injection of volcanic ash and by gas-to-particle conversion processes after the eruption. The Italian group's stratospheric lidar became operational by the end of March 1982 and was thereby able to observe the changes in stratospheric aerosol concentration that followed the eruption of the volcano, through the initial build-up of the aerosol concentration over Frascati, Italy, and well into a period of declining concentration. The Frascati lidar is now one of the most powerful lidar systems in operation. It uses an array of 36 spherical mirrors as a mosaic telescope with a 5 m^2 collection area as the receiver for the optical radar system. A frequency doubled Nd:YAG laser is used in the transmitter to provide simultaneous 0.53- and 1.06-micrometer wavelength pulses. Details of the first year of operation of the lidar system have been presented by Adriani et al. (1983).

The evolution of the cloud structure above the Frascati site showed different phases. The first phase was characterized by the presence of thin layers of thickness less than 1 kilometer, transported by westerly winds in the height region below 20 km. These layers appeared some 20 days after the eruption. The second phase began in June 1982 with the arrival of aerosols at altitudes above 20 km carried westward by zonal winds until the particles reached the Frascati location. Until the end of July, the upper layer appeared to be detached from the lower layer -- showing high aerosol scattering ratios (with values up to 12) and complex stratifications with individual layers less than 1-km thick. The last phase in the evolution of the El Chichon layer began in Novmember 1982 when, due to circulation changes, large quantities of material moved toward the mid-latitudes and it appeared that the region between the tropopause and 30 kilometers was filled by the volcanic cloud.

A maximum in aerosol concentration was observed in the November 1982 to January 1983 time period. After March 1983, concentrations began to decline and the lower stratosphere was filled by aerosol particles in a relatively homogeneous manner, without the thin stratificiations that characterized the early phase after the eruption. Dual wavelength lidar observations made in the period from September through November 1983 (Gobbi et al., 1985) suggested that the optical properties of the aerosol particles were changing with height in the 15- to 20-km altitude interval. In April 1984, the stratosphere appeared to have returned to pre-eruption conditions.

Our plan to obtain airborne observations of stratospheric aerosol scattering properties relied on a continuing series of flights of NASA's U-2 aircraft to be funded through NASA's Aerosol Climate

Program (ACE). This program involved coordinated observations made by university, NASA, and NOAA groups operating a variety of aerosol and gas sampling instruments on the same aircraft, including a polar nephelometer to be developed and operated by the principal investigator. Polar nephelometers are designed to measure the amount of light scattered by airborne particulates as a function of angle from a collimated beam of light. Earlier polar nephelometer measurements by the principal investigator included a ground-based study to determine te complex index of refraction of airborne soil particles (Grams et al., 1974), a series of airborne observations of the optical properties of aerosols in the troposphere and lower stratosphere (e.g., Grams, 1981), and laboratory experiments on the optical properties of airborne particles as a function of their size, shape and refractive index (e.g., Grams and Coletti, 1982).

The ACE project was initiated prior to the beginning of the present U.S.-Italy cooperative science program as part of a NASA special study which, in conjunction with satellite observations such as the SAGE experiments and other related aerosol programs, could provide comprehensive data sets and analytical capabilities for evaluating the impact of stratospheric aerosols on the Earth's climate, for testing climate models by studying the properties and effects of a large volcanic eruption, and for determining the influence of aerosols on remote sensing techniques. Mounting a nephlometer on the U-2 aircraft required an entirely new approach for measuring the aerosol scattering functions. The design of the new nephelometer was based on the use of an image-intensified scanned-diode array in the focal plane of a wide-angle "fisheye" lens to detect and measure the amount of light scattered from a collimated helium-neon laser beam. The first data flights for the nephelometer were made during July 1983. Additional stratospheric data were obtained in December 1983 and July 1983. The nephelometer was also flown as part of the aerosol instrument package operated on NOAA's P-3 aircraft as part of the Arctic Gas and Aerosol Sampling Program (AGASP) study of Arctic haze layers (Schnell, 1984). Preliminary results of those experiments have been reported by Grams (1984) and Patterson and Grams (1985). Unanticipated problems in maintaining calibration of the 512 detector elements in the scanned diode array caused uncertainties in the scattering measurements when the ratio of aerosol to molecular scattering was small -- as was the case for stratospheric observations made as part of the ACE program. These uncertainties made it impossible for us to try to infer water to sulfuric acid ratios from the scattering observations, as we had hoped to do when this effort was initiated. Instrument modifications are possible to correct the diode array calibration problem, but support for NASA's coordinated ACE program was discontinued after the July 1983 flights, and the opportunity to operate the nephelometer on the U-2 in the stratosphere no longer exists. We therefore point out that the Italian lidar observations of the El Chichon dust layers represent the major result of the experimental portion of our cooperative program.

References

Adriani, A., F. Congeduti, G. Fiocco and G.P. Gobbi, 1983: One-year lidar observations of the stratospheric aerosol layer following the El Chichon eruption. Geophys. Res. Lett., 10, 1005-1008.

Crescentini, L., and G. Fiocco, 1983: Possible effects of stratospheric aerosol layers on the vertical transport of water. Nuovo Cimento, 6C, 337-349.

Fiocco, G., and G.W. Grams, 1971: On the orgin of noctilucent clouds: Extraterrestrial dust and trapped water molecules. J. Atmos. Terr. Phys., 33, 815-824.

Gobbi, G.P., R. Ligi, A. Adriani, G. Fiocco, and F. Congeduti, 1985: Two wavelength lidar observations of the stratosphere and inferences on the size distribtion of the El Chichon aerosols. In IRS 84: Current Problems in Atmospheric Radiation (G. Fiocco, Ed.), A. Deepak Publising.

Grams, G.W., 1981: In-situ measurements of scattering phase functions of stratospheric aerosol particles in Alaska during July 1981. Geophys. Res. Lett., 8, 13-14.

Grams, G.W., 1984: Airborne polar nephelometer observations of stratospheric aerosol and Arctic haze particles during 1983 and 1984. In IRS 84: Current Problems in Atmospheric Radiation (G. Fiocco, Ed.), A. Deepak Publishing.

Grams, G.W., and A. Coletti, 1982: Analysis of nephelometer data obtained at the First International Workshop on Light Absorption by Aerosol particles. In Light Absorption by Aerosol Particles (H.E. Gerber and E.E. Hinman, Eds.), Spectrum Press, Hampton, Va.

Grams, G.W., I.H. Blifford, Jr., D.A. Gillette and P.B. Russell, 1974: Complex index of refraction of airborne soil particles. J. Appl. Meteor., 13, 459-471.

Patterson, E.M., and G.W. Grams, 1985: Analysis of Artic haze scattering and aerosol data obtained durig AGASP. Final Report, U.S. Army Research Office Contract No. DAAG29-83-K-0163, School of Geophys. Sci., Georgia Tech, 39 pp.

Schell, R.C., 1984: Arctic haze and the Arctic Gas and Aerosol Sampling Program (AGASP). Geophys. Res. Lett., 11, 361-364.